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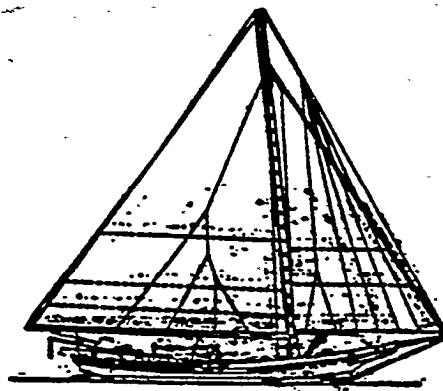
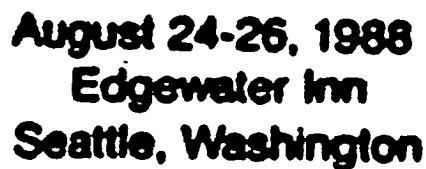
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Zone Logic Applications for Submarine Overhauls

Ernest D. Ellsworth, Visitor, and H. Bruce Bongiorno, Associate Member, Portsmouth Naval Shipyard, Kittery, ME

No. 5B

Abstract

Japanese shipbuilding methods have typically been applied in new ship construction. As new buildings decline, the ship repair market has become more competitive and shipyards have started to apply some of these principles to ship repair. Public shipyards have been the most active in this technology development. This paper addresses some of the history and problems that have been encountered at Portsmouth Naval Shipyard in the application of zone outfitting methods.

Introduction

Interest in zone outfitting methods has grown as the Navy deals with reduced budgets and increasing costs. Portsmouth Naval Shipyard is one of several public shipyards that has recently started to use zone outfitting methods in the overhaul environment (specifically nuclear submarines). In this paper we will present our efforts in the hope that our experiences will add to the existing body of knowledge.

Portsmouth Naval Shipyard is located in Kittery, Maine on Seavey Island which is positioned on the border between Maine and New Hampshire. Unlike the other Navy shipyards, Portsmouth deals exclusively in repair, overhaul, and refueling of submarines. Application of zone outfitting methods to submarine work must be integrated with stringent quality control and documentation requirements that are not found in work on surface ships.

In efforts to reduce costs in maintaining and modernizing the fleets, the Navy has adopted a series of policies consistent with the Carlucci Initiatives (reference 1). These are:

- a) Implement increase competition
- b) Implement economic production rates
- c) Reduce time to procure
- d) Reduce apparent cost growth
- e) Improve reliability through simplification

- f) Improve schedule realism
- g) Provide more apparent design-to-cost goals

Detailed goals and actions for putting these policies into place were identified in a study performed by Coopers and Lybrand on contract to the Secretary of the Navy.

Efforts at other shipyards

With the stage set by the Carlucci Initiatives and the Coopers and Lybrand report, public shipyards are beginning to adopt appropriate Japanese methods and new technologies. Significant among these are zone management methods similar to those practiced in new construction.

Puget Sound Naval Shipyard in Bremerton, Washington, has been very active in the implementation of zone outfitting methods (reference 1).

In most of these projects, no cost tracking was reported so benefits were recognized qualitatively. However, in one of these projects a reduction of 35% of total estimated cost and schedule performance improvement of 45 days was quantitatively documented.

Subsequently, Puget has applied zone outfitting to the structural work for ShipAlts on the forward end of SSN637 class submarines. On three submarines, traditional methods were used and on four zone outfitting was used. Final cost accounting reported an average savings of about 10% in man hours of which nearly half was overtime when zone outfitting was applied.

Technology transfer has not been limited to just zone outfitting methods. Pearl Harbor Naval Shipyard has begun a Program they call Total Quality Management (reference 2). This program is dedicated to constant process improvement and, thereby, quality improvement. Zone outfitting and work packaging are parts of this more general management

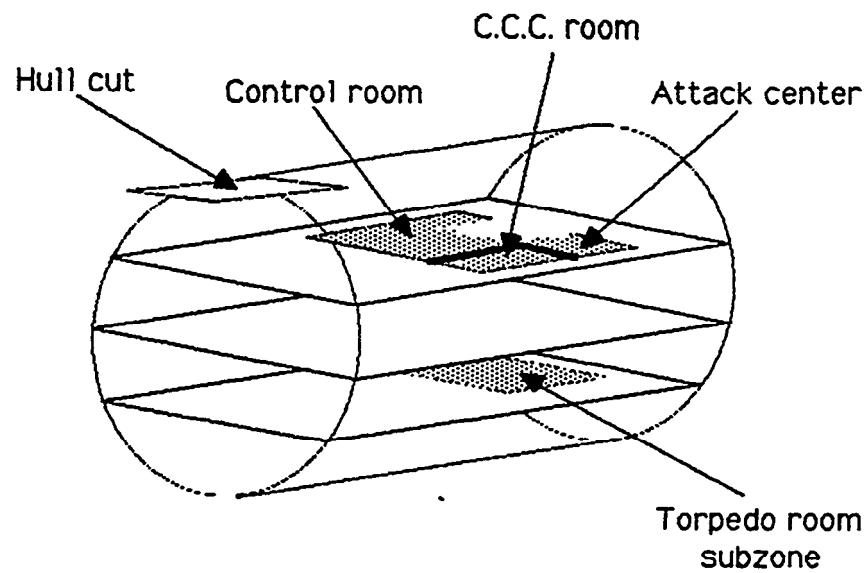


figure 1 - USS Bluefish Pilot Project

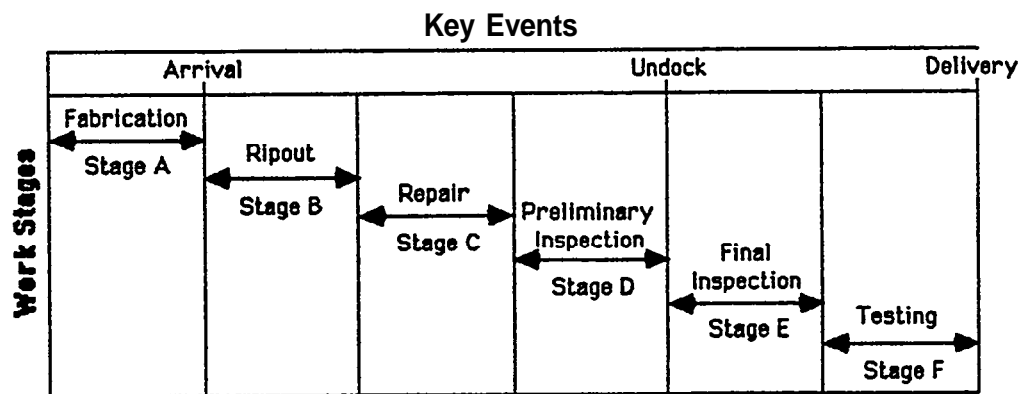


figure 2 - USS Bluefish Work Stages

philosophy. As did Puget Sound, Pearl Harbor has reported significant improvements in work performance on submarine modernization projects.

Philadelphia Naval Shipyard has retained consultants from Ishikawajima-harima Heavy Industries to help apply zone outfitting methods to the SLEP (Service Life Extension Program) of the USS Kitty Hawk. Although no papers have been published regarding these efforts, review of documentation provided to us shows that there is a high degree of schedule and resource visibility. The resulting control of the project will undoubtedly improve the overhaul performance.

Efforts at Portsmouth

In November 1985, Portsmouth Naval Shipyard management established the Adhoc Committee on Work Packaging to investigate methods to increase productivity through improved work instructions and better means of providing mechanics resources they need. The Major conclusions from their investigation were that significant improvements in cost and schedule performance could be realized by:

1. Developing detailed sequencing of work by geographic zone on the ship.
2. Grouping like work by zone in a set of work instructions.
3. Providing self-contained work instructions that cover events in a 1 to 3 week time horizon while minimizing support from assist trades.
4. Palletizing material to support the work instructions and schedule.

Since these findings were consistent with concepts from the National Shipbuilding Research Program (NSRP), transfer of these technologies became the committee's recommendation. Subsequent to the committee presenting it's findings, an assistant to the Planning Officer was assigned to facilitate implementation. His task was to identify pilot project opportunities and determine to what extent Portsmouth management should attempt to implement the committee's recommendations. The intent has been to gain experience with the technologies and management approaches and to best determine the path for transition.

Zone Outfitting on the USS Kamehameha

The overhaul of the USS Kamehameha was selected as the first opportunity to try zone outfitting concepts. The pilot project in this case was limited to sequencing component rip-out and reinstallation by zone. The ship was divided into geographic zones associated with common access cuts. Ship-checking of the areas identified major interferences in

the rip-out paths in those zones and these were considered in determining rip-out sequences. A strategy was developed for the rip-out sequence and a schedule was then created to control events and measure progress.

The project Management Team reported that the rip-out and reinstallation went smoother than on previous overhauls. Trade tasks were better integrated with less lost time, manning levels were lower than normal practice, and scheduled completion dates were met. This approach to organizing work was expanded in the next pilot project on the overhaul of the USS Bluefish.

Zone Outfitting on the USS Bluefish

Portsmouth developed a pilot project on the overhaul of the USS Bluefish. The intention of this pilot project has been to explore the technical, management, and organizational issues involved in evolving from a system-oriented philosophy to a zone-oriented approach to overhaul work.

Applying zone concepts to repair and overhaul and involved the following:

- a) Division of the ship into geographic work zones
- b) Division of the overhaul period into work stages
- c) Detailed sequencing of work in the zones
- d) Scheduling of the work by zone considering manpower resources and work space constraints

The above efforts have been supported by:

- a) providing detailed work instructions (Unit Work Procedures) such that no reference materials will be required by the mechanics
- b) palletizing of material for mechanics based on Unit Work Procedures
- c) participation of production personnel in the planning process

The pilot project has included all the authorized work within the zones shown in figure 1. The primary work has been ShipAlt (ship alteration) 1929 (K), CCS MK 01 MOD 0 installation, an upgrading of the torpedo fire control system. Work from other ShipAlt's and regular overhaul work requirements in the scope of zone planning.

The original zones were defined as:

- zone 101- attack center
- zone 102- control room, aft end
- zone 103- central computer complex
- zone 104- passage
- zone 304- torpedo room forward center

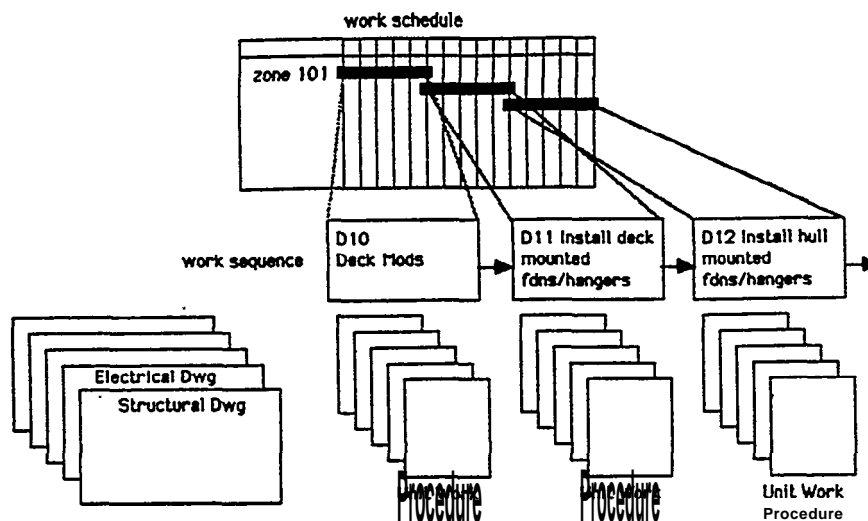


figure 3 - Diagram of Unit Work Procedure Development

Work stages were defined as shown in figure 2:

- A - fabrication
- B - rip-out
- C - repair
- D - preliminary installation
- E - final installation
- F - systems testing and completion

The methods described above were applied to the structural and electrical work. Unit work procedures were not generated for mechanical, piping, and ventilation. However, this work was included in work sequencing and scheduling.

Prior to the start of the overhaul, the decision was made to expand the project to include the operations compartment. This work involved extensive cabling modifications in zone 105, the sonar room, and zone 107, the radio room.

Major work included in the project was to upgrade sonar, radio, and navigation equipment in addition to upgrading of the fire control systems. This required extensive structural, as well as cabling modification. Changes were also required in several piping systems. All of these activities had an impact on insulation and painting.

Testing requires system orientation, that is, tests are conducted as systems are completed. Testing of systems in the zones was not part of the pilot project, but was taken into account in the scheduling. System completion dates to support the integrated test schedule were taken as zone completion milestones.

Unit Work Procedures

Unit Work Procedures were developed for this project similar in format and content to what was done at Puget Sound Naval Shipyard and discussed in reference 1. This process involves converting information that was presented by system into a package that presents it organized according to the ship's geographic zones and consistent with process sequences (figure 3).

Each package contained the information that a mechanic needed to perform the scheduled task. This included isometric diagrams of the components to be removed or installed, detailed work instructions, safety information, and a list of required material.

The Unit Work Procedures also provided the necessary signature documentation for verification of work completion, work quality control, and accountability. All of this information is critical to insuring the safety of the submarine and satisfying the quality control audit requirements.

CAD modeling and use of a database program have been transition planning efforts. CAD modeling of structural work was used to provide graphics for Unit Work Procedures in the same way as has been done at Puget Sound Naval Shipyard and documented in reference 2. However, what proved to be equally useful in the grouping of work was using a commercial database program on a personal computer. Using an appropriate coding scheme, the database program allowed retrieval of information to form work packages and identify similar work to be performed in a zone. This was used extensively for electrical work.

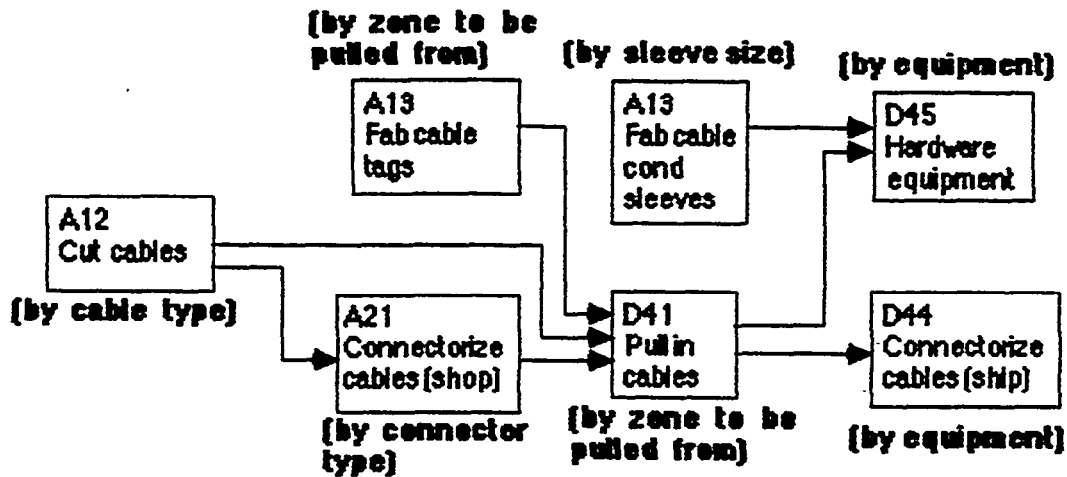


figure 4 - Organization of Unit Work Procedure Information to Facilitate Use of Group Technology in Electric Cable Fabrication/Installation Process

In developing the PC coding scheme for effective retrieval of information, processes were defined and a coding system was established to identify interim products. The database could be sorted for selected features to facilitate application of group technology and development of Unit Work Procedures. This is shown in figure 4.

Organizational correlates

Zone outfitting is a management technology relying as much on who does the planning, scheduling, and control as the actual tools for organizing the work. The intent of breaking the ship down into zones is to reduce the management tasks in size by being product-oriented rather than by system. This allows the zone manager to integrate and control predecessor/successor events and resource allocation. In this case the resources are manpower, material, and calendar time.

The Bluefish pilot project used two organizational concepts to support zone methods. The first involved designating a Zone Manager whose responsibilities were to direct work in the zones and integrate trade efforts.

The second was creating a Zone Planning Team. Core members were representatives from Design Division and production shop personnel. Representatives from the Planning and Estimating department, scheduling, combat systems, and additional shop personnel were added as needed.

The Zone Planning Team gathered in a series of meetings for the purpose of

grouping and sequencing work. The meetings were chaired by the zone manager. Deliverables from these meetings were integrated work sequences for the zones.

Another responsibility of the core Zone Planning Team was to participate in the CAD modeling efforts and the development of the Unit Work Procedures. These tasks represented near full-time assignments for the shop personnel involved.

Lessons learned

Although the project is still in progress, several lessons have been learned that are worthy of sharing. The project significantly deviated from the normal methods of planning work and managing execution. Consequently the project could not be fully integrated into the Shipyard "system". The confusion this would cause during execution was not fully anticipated and has detracted from the successes achieved.

The Unit Work Procedures provided instructions to mechanics but did not replace the traditionally prepared Key Ops in the management system. This approach caused extra work for foremen in reporting costs and progress as well as preventing accurate UWP cost tracking. Since the UWPs did not replace key ops, they did not fully address trade requirements. This limited their usefulness as a manpower planning tool. In the next project, UWPs will be fully integrated.

Although material lists were included on UWPs, the material was not linked with ordering numbers in the

Shipyard MIS. This, also, caused considerable confusion and extra work. This will be corrected in the next project.

The zone manager, by virtue of his position outside the traditional Shipyard project management structure and with limited control over resources, had difficulty performing the trade integration function. His role was further weakened when schedulers with systems background had difficulty developing zone schedules that integrated all work. The credibility of the zone manager, however, has significantly improved since the early stages of the project with apparent corresponding work efficiency improvements.

The use of a relational data base manager for grouping like work and providing input to work instructions when graphics is not required has proven successful as a work management tool during execution of this work.

The mixing of engineering and production personnel in the zone planning team has proven to be an education to both groups. They enjoyed learning from each other. Some engineers have commented that this approach is their first realization that engineering should be concerned with execution cost effectiveness. A large scale and continuous sharing of knowledge between these groups has apparent potential to significantly improve shipyard performance.

The Depot Modernization Period

Portsmouth Naval Shipyard is scheduled to perform one of the first Depot Modernizations of a 688 class attack submarine. The philosophy of the Depot Modernization Period (DMP) is to reduce maintenance costs by going from time-based repairs and upgrading of systems to condition-based, fix-only-what-is-broken, repairs and upgrading of systems. The objective is to perform upgrading of systems within a rigid time frame and with a minimum of disruptive emergent work.

Portsmouth Management recognizes that such a concept is very different from past work that has been performed at the yard. Consequently, they recognize that a unique project management approach must be developed. Such management concepts require decentralization of decision making and rapid response to problems since no schedule slippage can be allowed.

Plans for the first DMP involve using a zone identification code with the cost collecting numbers (Key Ops). This will allow collection of work content information by zone. This

information can then be used to create zone schedules that integrate trade efforts.

Part of the management approach on latter DMP's will be to more fully incorporate zone outfitting concepts. Although it has not been decided when a fully developed zone management organization will be used, pilot projects are being defined in areas of greatest potential benefit. These projects will provide additional experience to facilitate implementation on following DMP's.

In particular, work to be performed in the after end of the engine room and the associated main ballast tanks is being considered as a zone technology project. The scope of this application would include all shipalt and repair work. Unit Work Procedures would be developed and a more flexible scheduling system similar to that used at Philadelphia Naval Shipyard would be used to control work.

Conclusion

As a result of our pilot projects at Portsmouth, we have concluded that zone outfitting methods can be effective in improving performance on submarine overhaul and repair work. The Shipyard will continue to implement zone methods on a selective basis. It is likely to continue to be refined and expanded in areas where it has the greatest potential benefit. However, factors unique to the nature of Portsmouth Naval Shipyard's work may prevent realization of the full potential improvements from shipyard-wide application of zone technology.

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